Center Innovation Fund: ARC CIF

Satellite Integration of a PhoneSat-EDSN Bus with a Micro Cathode Arc Thruster

Completed Technology Project (2014 - 2015)

Project Introduction

NASA Ames Research Center and GWU are investigating applications of Micro-Cathode Arc Thrusters (μCAT) sub-systems for attitude and orbit correction of a PhoneSat spacecraft. The ARC/GWUworked together to investigate the feasbility of integrating and controlling the GWU micro cathode arc thruster with the ARC PhoneSat bus avionics and software. At the conclusion of the feasibility study, the ARC/GWU team successfully demonstrated the integration and control of several micro cathode arc thrusters using the PhoneSat bus software architecture and a prototype bench model Plasma Processing Unit (PPU). The next task, in this effort to further mature this technology, is to develop bench model PPU (Plasma Processing Unit) into a Cubesat form factor and make it compatible with the PhoneSat-EDSN bus. Additionally this effort will demonstrate the performance of the integrated Phonesat, PPU and propulsion system in space or relevant environment.

NASA ARC and the George Washington University have collaborated together to integrate the micro cathode arc thruster with the PhoneSat architecture bus. This effort successfully demonstrated the integration and control of a bench model Plasma Processing Unit (PPU) and multiple thrusters with the PhoneSat bus software architecture in the laboratory bench top environment. The next logical step is to integrate the PPU and thrusters onto a single Cubesat form factor PCB that can easily assembled into a PhonesSat-EDSN 1.5U bus. The integrated Thruster/PPU/PhoneSat-EDSN Bus can demonstrate performance of the propulsion system in space or relevant environment.

The four main objectives of this proposal are:

1. Design of a PCB that will accommodate the PPU and 2 thrusters that fits in a 0.25U CubeSat volume (which corresponds to the actual available space for payloads in the EDSN bus)
2. Leverage all the EDSN design and make the necessary modifications to substitute the current payload (radiometer) by the thruster. This redesign is intended to be as minimal as possible
3. Develop the software needed to detumble the satellite using the current magnetorquers, and then spin it up with the thrusters measuring the rotational speed with the gyros of the phone

The completion of these objectives will not only provide a CubeSat with a propulsion system that could be tested in space, but will also confirm the adaptable design of the PhoneSat-EDSN bus to different payloads.

Potential ISS flights and other opportunities will be considered in order to fly the satellite.

The this project has utilized NASA Ames Space Shop facilities for laser cutting and 3D printing. It also used the Space Shop lab space to develop rapid circuit prototyping. The project will continue to use these facilities to be able to design quickly and low cost prototypes before integrating the entire system

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into a satellite.

Innovation:

In order to test the performance of the propulsion system in space, the thrusters will try to spin up the satellite along its long axis once it has detumbled. With the current design, the PhoneSat-EDSN architecture uses the magnetorquers to detumble the satellite. Measuring ΔV of a microNewton thruster would be very difficult for a short mission. However, it is certainly possible to spin up the satellite and measure its rotational speed using the phone’s gyros. One the satellite spin rate is high enough, the magnetorquers will detumble the spacecraft again. This maneuver will be tested several times to confirm and measure the performance of the thruster

This test flight will raise the TRL of the propulsion system from 5 to 7 and will be a first test for further CubeSats with propulsion systems, a key subsystem for long duration or interplanetary CubeSat missions.

Anticipated Benefits

This Element will benefit SSTP Technology Demonstration Missions.

This technology will benefit future NASA Small Satellite based missions in need of low mass, low power reaction control and micropropulsion thrusters.

Low cost, low power propulsion for Cubesats

This technology will benefit the Commercial and Academic Small Satellite and specifically Cubesat community.

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Harry Partridge

Project Manager:

Elwood F Agasid

Principal Investigator:

Elwood F Agasid

Co-Investigator:

Oriol Tintore Gazulla

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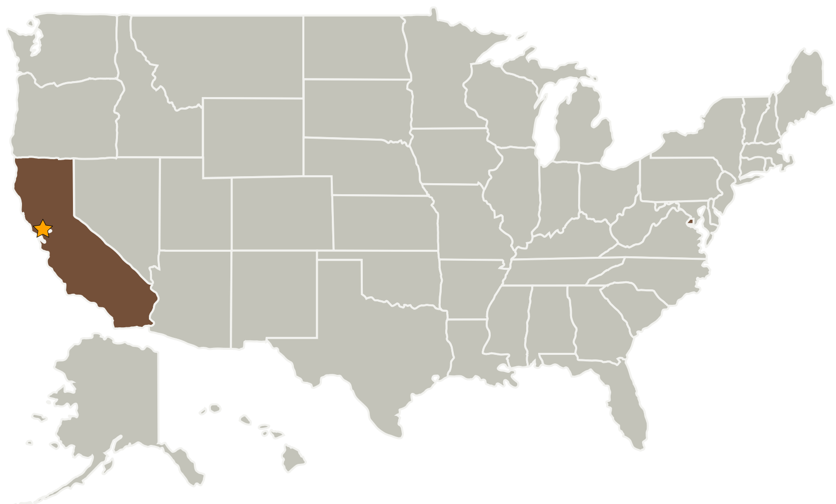
Primary U.S. Work Locations and Key Partners



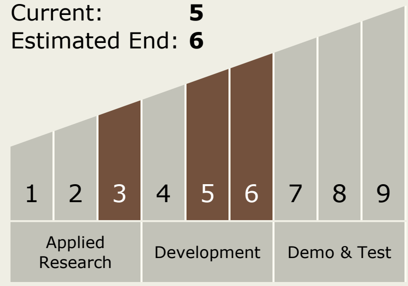
Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
George Washington University	Supporting Organization	Academia	Washington, District of Columbia

Co-Funding Partners	Type	Location
George Washington University	Academia	Washington, District of Columbia

Primary U.S. Work Locations	
California	District of Columbia

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **6**



Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.2 Electric Space Propulsion
    └ TX01.2.2 Electrostatic

Stories

1676 Approval #17536
(https://techport.nasa.gov/file/8745)

PhoneSat-EDSN Bus with a Micro Cathode Arc Thruster Project Tested
(https://techport.nasa.gov/file/27027)